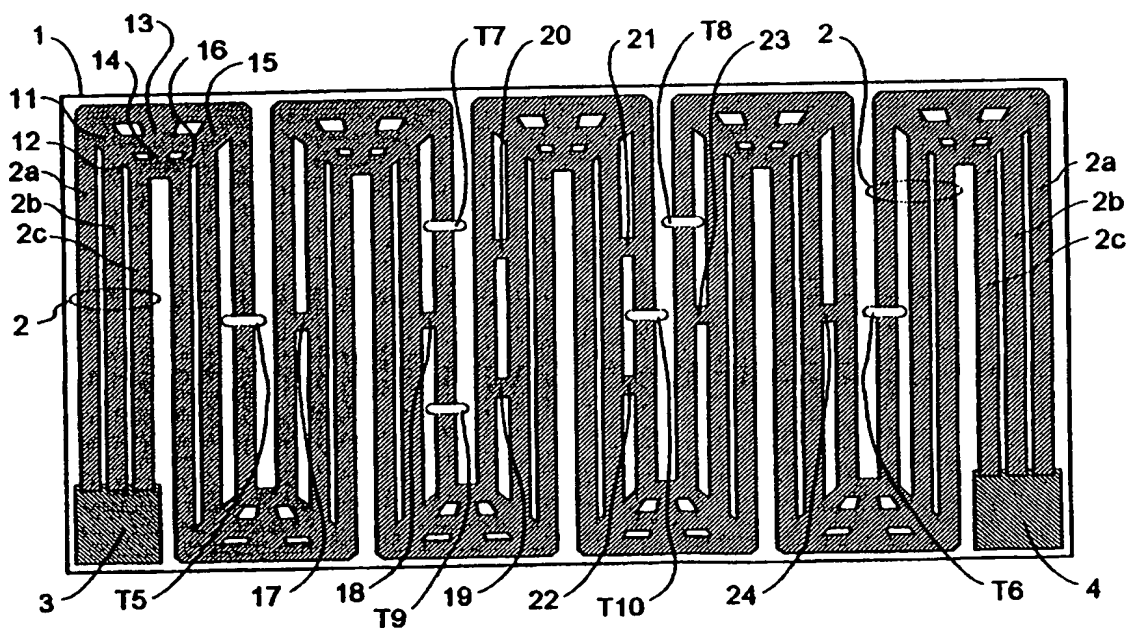




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H01C 7/12	A2	(11) International Publication Number: WO 99/56291 (43) International Publication Date: 4 November 1999 (04.11.99)
(21) International Application Number: PCT/FI99/00336 (22) International Filing Date: 26 April 1999 (26.04.99) (30) Priority Data: 980905 24 April 1998 (24.04.98) FI (71)(72) Applicant and Inventor: MÄÄTTÄ, Hannu [FI/FI]; Pika- isaarentie 1 C 37, FIN-90100 Oulu (FI). (74) Agent: LAURINOLLI, Tapio; Patenttitoimisto Tapio Lauri- noli, P.O. Box 258, FIN-90101 Oulu (FI).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>In English translation (filed in Finnish). Without international search report and to be republished upon receipt of that report.</i>

(54) Title: SURGE PROTECTOR



(57) Abstract

Surge protector which includes a film pattern (2) formed on a suitable substrate (1) is characterized in that the film pattern (2) essentially consists of narrow lines (2a, 2b, 2c) which extend parallel and adjacent to each other and are electrically in parallel relationship to each other, and bridges (11-24) between the lines. Advantageously, there are three parallel lines. The resistance of the film pattern (2) is trimmed advantageously by cutting off (T5, T6, T7, T8, T9, T10) one of the lines (2c) between successive bridges.

2 / parts.

422 Rec'd PCT/PTO 24 OCT 2000

Surge protector

The invention is related to surge protectors manufactured by film techniques and provided for warding off and withstanding high instantaneous overvoltage pulses.

5 One way of manufacturing this kind of surge protectors is to form a serpentine shaped or technically equivalent film pattern of material with suitable resistance on a suitable substrate with good thermal conductivity. As the high frequency current of a overvoltage pulse is concentrated in the edges of the film, a serpentine shaped or technically equivalent narrow film line causes that the current and at the same time the heating up are distributed relatively evenly over a large area on the substrate.

10 Today, a preferred manufacturing technique of this type of surge protection resistors is thick film technology in which the substrate is a ceramic substrate and the film is made of material specifically manufactured for this kind of applications. One manufacturer of this kind of materials is DuPont Electronic Materials having thick film material series 15 7300 and 7400 for these purposes. These materials are suitable compositions of, e. g., silver, palladium and glass material which provide a low temperature coefficient of resistance, high enough trimming accuracy and good stability against the effects of overvoltage pulses. The resistivity of a resistor film is typically from 100 to 1000 m Ω /□. The resistor film may be further protected by a suitable glazing or equivalent which 20 reduces oxidization and change of properties caused thereby as the effect of an overvoltage pulse is heating up the resistor and the substrate.

Surge protection components manufactured by thick film technology include often several protection resistors on one substrate, either adjacent to each other on the same side of the substrate or as printed on the both sides of the substrate. They are widely used 25 in telecommunication equipment, and, e. g., for protecting telephone lines each conductor of a line needs its own protection resistor. An absolute tolerance of 5 % and a relative tolerance of 1 % are normal requirements for protection resistors. Therefore the resistors are to be trimmed. For trimming the pattern, serpentine, spiral or equivalent, is designed to included a suitable amount of bridges so as to lengthen the line by cutting bridges until 30 the desired value is reached. Because only a tolerance of ± 30 % may be obtained without trimming, the possible need for wide range trimming must be taken into account. That is to say, there must be enough bridges. On the other hand, if the need for trimming is small, the most of the bridges are not cut and the current of the overvoltage pulse is flowing through the bridges. Then, there exist a lot of parts in the film pattern through which the

current is not flowing. This means that cold spots are left on the substrate, and the failure risk of the resistor component is increased.

Several solutions are developed to overcome this problem, a widely used solution being demonstrated by the example of Figs. 1 and 2. A narrow film line 2, which forms a protection resistor, makes a serpentine shaped pattern on the substrate 1 between contact areas 3 and 4. The width of the line may be 0.5 to 1 mm, for example. At several places a line coming to and a line leaving a turning point 6a ... 6h are connected by a bridge 5a ... 5h, respectively, and at a place close to the contact area 4 there is a special loop 6i of line 2. The resistance of the serpentine pattern is trimmed by appropriately cutting bridges, as is indicated by the arrow T at the bridge 5a in Fig. 1 and by trimming points T1, T2, T3 and T4 indicated by broken line in Fig. 2. As a bridge is cut, the resistor formed by the serpentine is lengthened and the resistance thereof is increased. In the example of Fig. 2, scarcely anything of the current of an overvoltage pulse flows through the loops 6b, 6c, 6e and 6h, and so these places remain colder than the circumference thereof during the influence of a pulse.

The solution of US patent 4 999 731 is, in principle, the same as the solution of Figs. 1 and 2. Therein, the trimming points are placed as close as possible to the edges of the substrate and the serpentine pattern by means of which the temperature distribution is made even especially in the central area of the substrate.

On the other hand, US patent 5 057 964 presents a solution based on a spiral pattern. The trimming is made by cutting only bridges in the central area of the spiral. In this case the temperature distribution is even in the peripheral area of the pattern, but the central parts of the spirals remain the colder the less the resistors are trimmed.

An object of the invention is to present a solution by means of which the distribution of the current is made as even as possible both without any trimming at all and with various trimmings.

For realizing this and other objects of the invention the surge protector in accordance with the invention is characterized by the features defined by claim 1 of the appended claims. Other claims define various embodiments of the invention.

The solution in accordance with the invention is characterized in that the film pattern essentially consists of narrow lines, which extend parallel and adjacent to each other, and bridges between the lines. Advantageously, there are three parallel lines, and for trimming the resistance of the film pattern only one of the lines is cut off between successive bridges. So, for the high frequency current to flow, there are still two film lines and four edges thereof in which the flow of the current is concentrated. As the lines are close to

each other, only a relatively narrow band is left at each trimming point in which the current does not flow and heat up the substrate during the influence of a pulse. The trimming points may be placed in such a way that active lines are located at each side thereof, whereby the heat is distributed in the thermally conducting substrate quite well also to the area of the line cut off by trimming.

The invention and some embodiments thereof are explained in more detail in the following with reference to the attached drawings, wherein:

Figs. 1 and 2 present schematically a prior art realization of a surge protector, and

Figs. 3 and 4 present schematically an exemplary realization of a surge protector in accordance with the invention.

The prior art solution was considered above in the introductory part of the specification with reference to Figs. 1 and 2.

In Fig. 3, on a substrate 1 between contact areas 3 and 4 there is a film pattern including three parallel film lines 2a, 2b, 2c and bridges 11, 12, ... , 23, 24 therebetween, the pattern forming a surge protection resistor. The film pattern forms a serpentine which covers uniformly the area provided for the resistor. The contact areas 3 and 4 are made of conventional conductor material with good solderability while the film pattern is made of material meant for this kind of application, e. g. DuPont 7300 series material. The width of the lines may be of the order of 0.5 mm, for example. For making the distribution of the current even, the lines are advantageously manufactured in such a way that they have essentially the same resistance between the contact areas 3 and 4. Also advantageously, the bridges at the turning areas of the serpentine are made so that the resistance of each line within the turning area is essentially the same. The current of a pulse is then distributed evenly also within the turning area. In the figures, therefore, the bridges 11, 12; 13, 14; 15, 16 and the other similar bridges within the turning areas of the serpentine are widening towards the edge of the substrate. The trimming is here meant to be made by cutting off line 2c at suitable points. Other bridges 17, 18, 19, 20, 21, 22, 23, 24 are therefore only between lines 2b and 2c. Film lines 2a and 2b are positioned quite close to each other while line 2c is at a little greater distance from line 2b for making the trimming easier.

Fig. 4 presents an example of trimming the film pattern. In this case, the resistance within the desired tolerances is obtained by cutting off line 2c at points T5, T6, T7, T8, T9 and T10.

As stated above, the film pattern forming the resistor is normally covered by a glazing or other suitable protective coating which improves the properties of the

protection resistor, e. g. reduces the change of the resistance value caused by a pulse. The trimming, normally laser trimming, is made through the protective coating. Leads are attached by soldering to the contact areas for connection to a printed circuit board, for example, and a surge protector in a form of a conventional SIL or DIL type hybrid circuit is obtained.

Here, only one protection resistor covering the whole area of substrate 1 is presented schematically, but there are often several protection resistors and may be also some other resistors and sometimes other electronic components placed on the same side or on the both sides of a substrate.

There may be also more than three parallel film lines, but for example in the serpentine embodiment the number three of lines is advantageous. The widths of the lines may differ from each other to some extent, and also the width of each line may vary within certain limits. Also the positioning of the bridges and trimming points may vary widely.

Serpentine pattern is an advantageous way of realizing the invention but, in principle, also a spiral type realization, which is used in similar protection resistor applications, is possible.

The surge protector of the invention may also be accomplished with other suitable technology than thick film technology which, however, is obviously very advantageous way of realizing the invention.

The invention may vary within the scope of the appended claims.

Claims

1. Surge protector which includes a film pattern (2) formed on a suitable substrate (1),
characterized in that the film pattern (2) essentially consists of narrow lines (2a, 2b, 2c)
5 which extend parallel and adjacent to each other and are electrically in parallel
relationship to each other, and bridges (11 - 24) between the lines.
2. Surge protector of claim 1, **characterized** in that the number of parallel lines (2) is
three (2a, 2b, 2c).
- 10 3. Surge protector of claim 1 or 2, **characterized** in that between two successive bridges
(15, 17) only one (2c) of the lines (2a, 2b, 2c) is cut off (T5, T6, T7, T8, T9, T10) for
trimming the resistance value of the film pattern.
- 15 4. Surge protector of any preceding claim, **characterized** in that the film pattern is
formed between two points (3, 4) so that the length and resistance of each parallel line
(2a, 2b, 2c) between said points are essentially the same.
- 20 5. Surge protector of any preceding claim, **characterized** in that the pattern formed by
parallel lines (2) is a serpentine or technically equivalent pattern for making the high
frequency current of a pulse concentrating in the edges of the film lines to be distributed
evenly over the substrate covered by the film pattern.

1/2

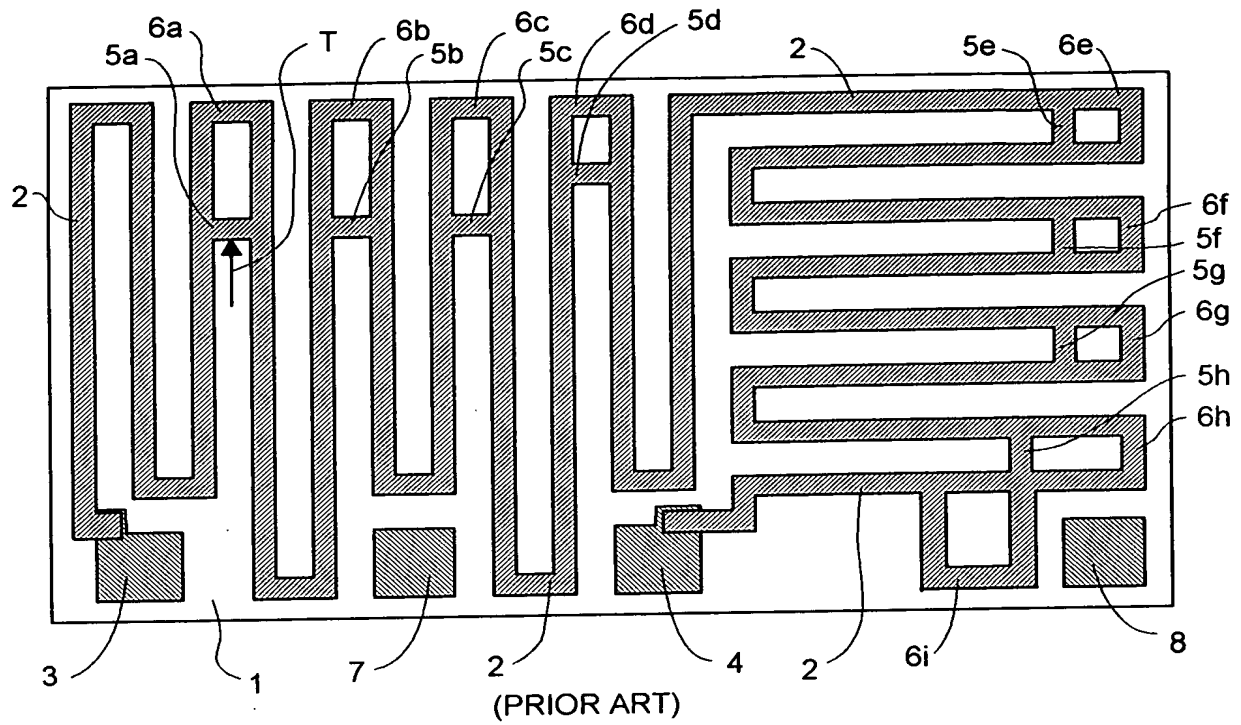


Fig. 1

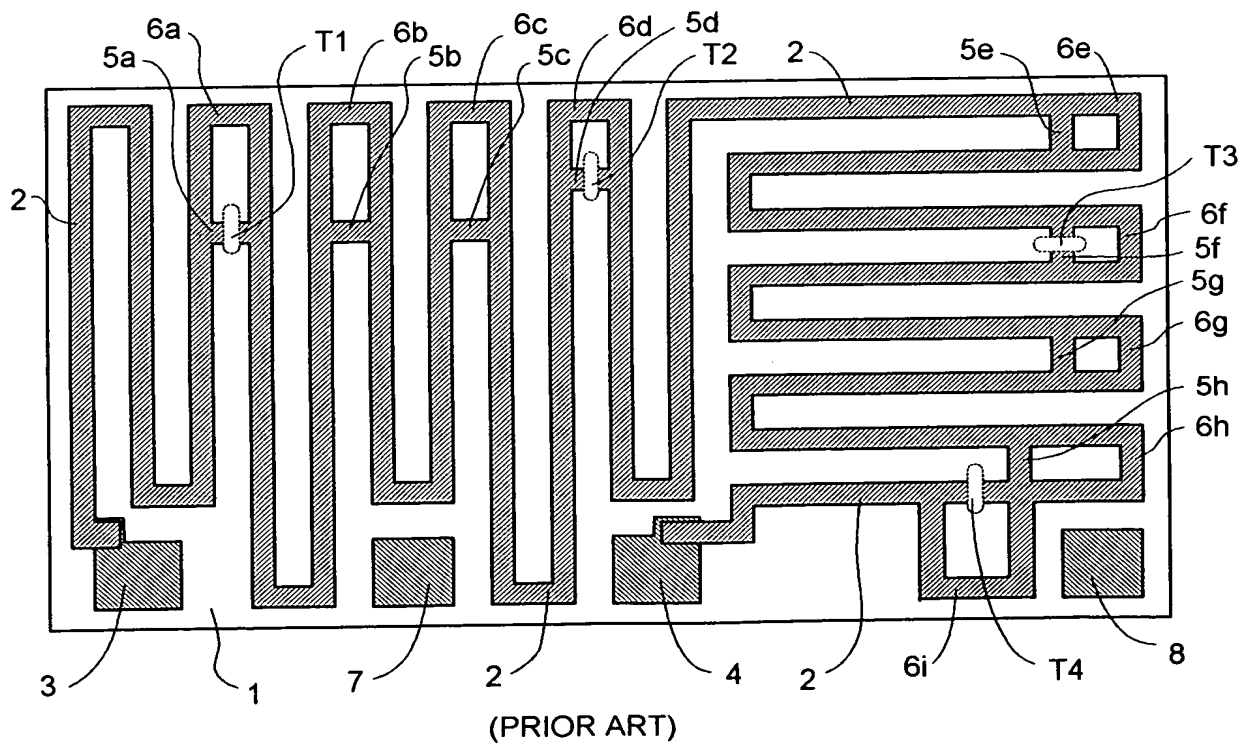


Fig. 2

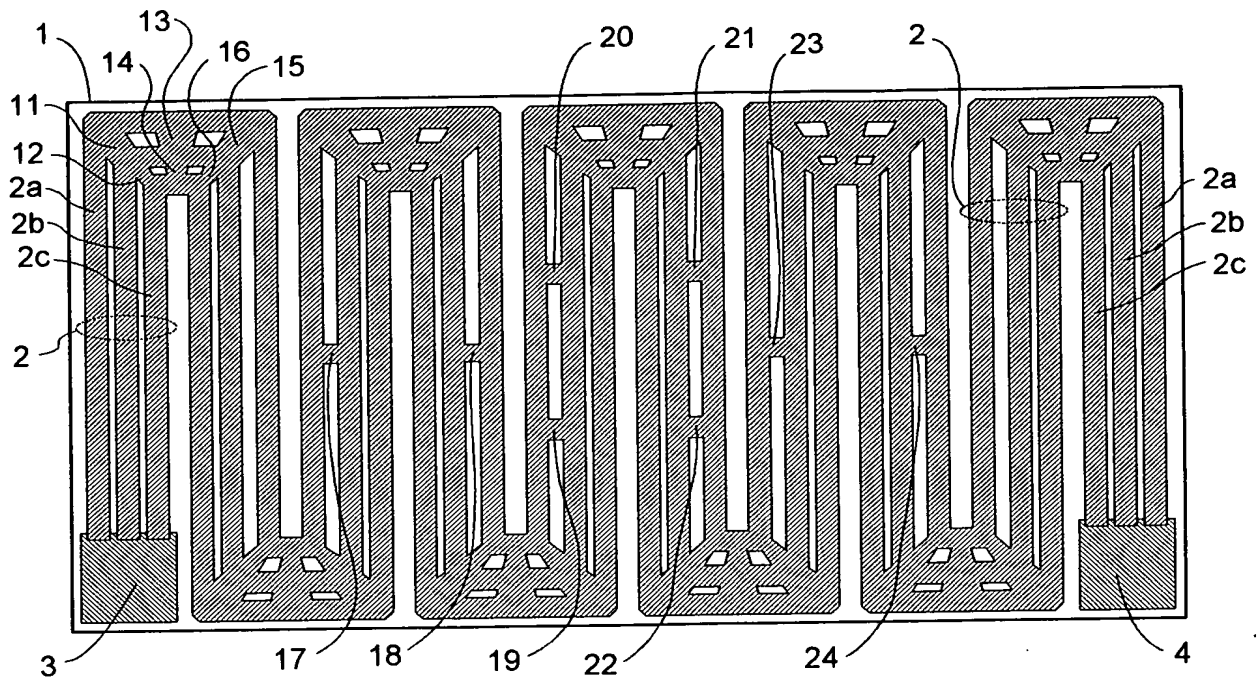


Fig. 3

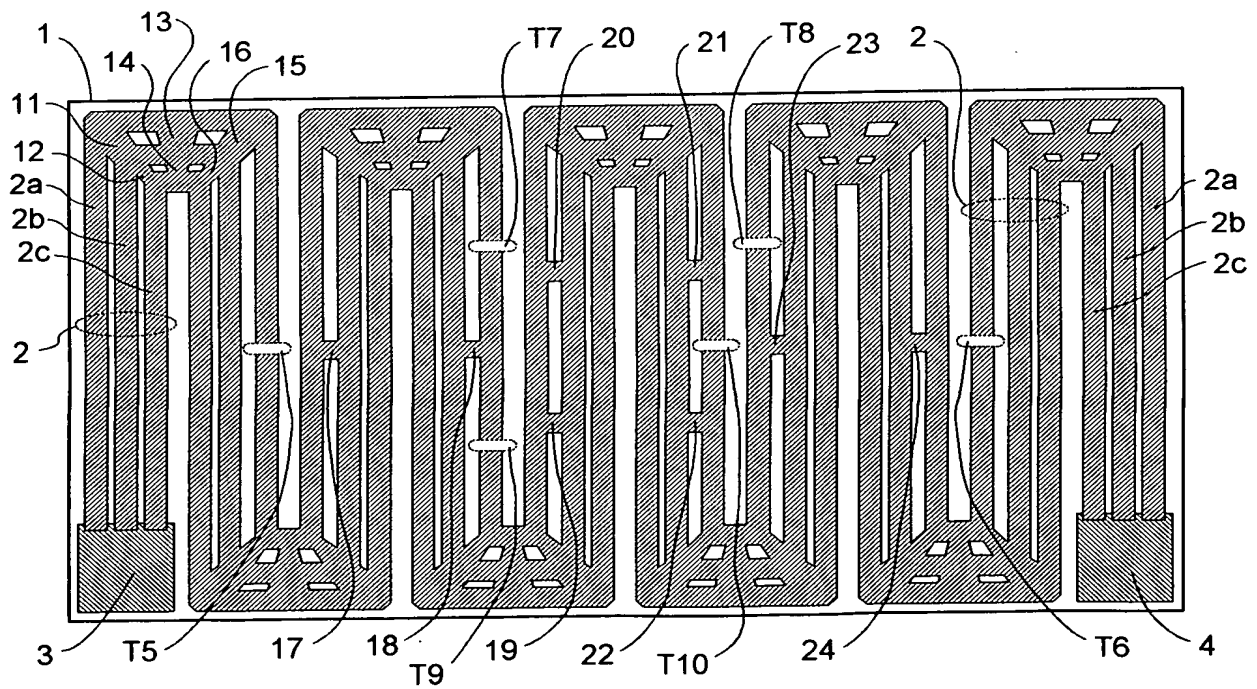


Fig. 4



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

1) International Patent Classification⁶ :

H01C 7/12

A3

(11) International Publication Number:

WO 99/56291

(43) International Publication Date:

4 November 1999 (04.11.99)

(21) International Application Number: PCT/FI99/00336

(22) International Filing Date: 26 April 1999 (26.04.99)

(30) Priority Data:

980905

24 April 1998 (24.04.98)

FI

(71)(72) Applicant and Inventor: MÄÄTTÄ, Hannu [FI/FI]; Pikaareentie 1 C 37, FIN-90100 Oulu (FI).

(74) Agent: LAURINOLLI, Tapio; Patenttitoimisto Tapio Laurinoli, P.O. Box 258, FIN-90101 Oulu (FI).

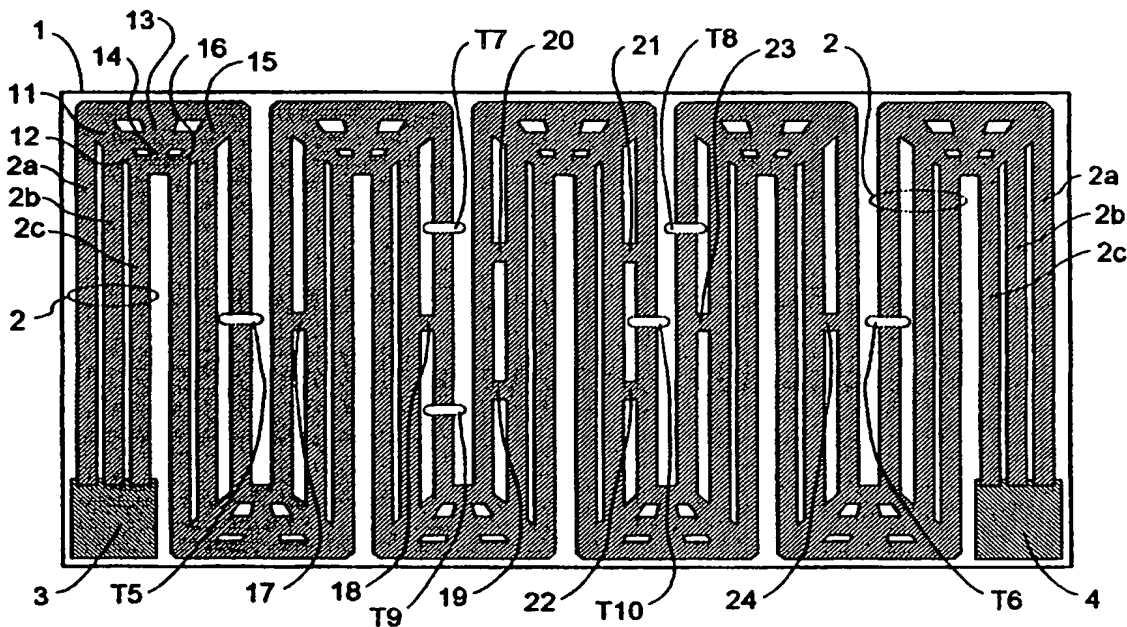
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published*With international search report.**Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.**In English translation (filed in Finnish).*

(88) Date of publication of the international search report:

16 December 1999 (16.12.99)

(54) Title: SURGE PROTECTOR



(57) Abstract

Surge protector which includes a film pattern (2) formed on a suitable substrate (1) is characterized in that the film pattern (2) essentially consists of narrow lines (2a, 2b, 2c) which extend parallel and adjacent to each other and are electrically in parallel relationship to each other, and bridges (11-24) between the lines. Advantageously, there are three parallel lines. The resistance of the film pattern (2) is trimmed advantageously by cutting off (T5, T6, T7, T8, T9, T10) one of the lines (2c) between successive bridges.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00336

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01C 7/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPIL, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0271993 A2 (NORTHERN TELECOM LIMITED), 22 June 1988 (22.06.88) --	1
A	US 4794367 A (JAMES ASHE ET AL), 27 December 1988 (27.12.88) --	1
A	US 4999731 A (DAVID K. BENDER ET AL), 12 March 1991 (12.03.91) -- -----	1

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 October 1999

Date of mailing of the international search report

21-10-1999

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Magnus Westöö/MN

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/09/99

International application No.

PCT/FI 99/00336

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
EP	0271993	A2	22/06/88	SE	0271993	T3	
				CA	1292503	A	26/11/91
				DE	3781776	A	22/10/92
				JP	63171118	A	14/07/88
				US	5057964	A	15/10/91
<hr/>							
US	4794367	A	27/12/88	EP	0230761	A	05/08/87
				GB	2184893	A,B	01/07/87
<hr/>							
US	4999731	A	12/03/91	CA	1283162	A	16/04/91
<hr/>							